ACCESSION #: 9710210126
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Harris Nuclear Plant Unit-1 PAGE: 1 OF 5

DOCKET NUMBER: 05000400

TITLE: Reactor trip due to the failure of a switchyard breaker
disconnect switch.
EVENT DATE: 4/25/96 LER #: 96-008-02 REPORT DATE: 10/14/97

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100%

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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Licensing

COMPONENT FAILURE DESCRIPTION:
CAUSE: E SYSTEM: EL COMPONENT: Disc MANUFACTURER: M230
X KE RLY W120
REPORTABLE NPRDS: Y
Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On April 25, 1996 at approximately 2107 with the unit operating in Mode 1 at 100% power, a turbine trip/reactor trip occurred due to a main generator lockout. The generator lockout was caused by the failure of a manual disconnect for one of two unit output breakers. At the time of the failure, full generator output was being routed through the breaker whose disconnect failed. During the 1E Bus (B train bus) fast transfer process from the Unit Auxiliary Transformer to the Startup Auxiliary Transformer, a momentary contact closure caused a false under-voltage signal. This under-voltage signal resulted in a loss of power to several electrical busses. Secondary system equipment was secured due to the loss of Normal Service Water. The "A" Emergency Service Water pump started and supplied its header. The "B" bus under-voltage signal caused the Loss of Offsite Power sequencer program to start. Appropriate "B" train safety equipment started as required. The "A" train successfully completed a fast transfer to the Startup Auxiliary Transformer. However, the "A" Emergency Diesel Generator Control Panel status lights indicated that the EDG was in the "Maintenance" mode, rather than the "Operational" mode, which indicated a circuitry problem. Subsequent investigation determined that these status lights were affected by the false under-voltage signal that had been generated. Isolation signals were received for the Containment and Control Room Isolation Systems due to radiation monitor power loss. At approximately 2152, it was noted that the Charging/Safety Injection Pump suction had transferred from the Volume Control Tank (VCT) to the Refueling Water Storage Tank. The swapover occurred due to the loss of electrical power to the boric acid flow transmitter. Operators stabilized the unit in Mode 3. The disconnect failure was caused by improper mating of the contact surfaces and inadequate preventive maintenance. The "A" and "B" phase disconnects for the affected breaker were replaced and the other switchyard disconnect switches were inspected for proper seating. After returning the unit to service, thermography monitoring of the unit output breaker disconnects showed elevated temperatures. The unit was taken off-line and the disconnect contacts on the generator bus sides of the unit output breakers were refurbished. The unit returned to service and subsequent thermography readings indicated expected operating temperatures for the disconnects. This LER revision provides additional information regarding the Normal Service System problems following the April 25, 1996 reactor trip.

END OF ABSTRACT

EVENT DESCRIPTION:

There are two 100% capacity unit output breakers, designated 52-7 and 52-9, which connect the main generator to the main switchyard south and north 230 KV buses, respectively. The breakers have manual disconnects on both the generator and 230 KV bus sides. Each disconnect has three poles, designated A phase, B phase and C phase. On April 25, 1996, at approximately 2045, Breaker 52-9 was taken out of service for maintenance, resulting in the full generator output being routed through Breaker 52-7. At approximately 2107 on April 25, 1996, with the unit operating in Mode 1 at 100% power, the A phase disconnect pole on the generator side of unit output Breaker 52-7 failed (EIIS Code: EL-DISC). This failure resulted in a short to ground which caused a generator lockout, a turbine trip and a reactor trip.

The resulting electrical perturbation caused several busses to lose power which caused the B Normal Service Water Pump to trip. (NSW, EIIS Code: KG-P). Operating personnel secured the running secondary plant equipment, including both main feedwater pumps, and broke condenser vacuum. Operators stabilized the unit in Mode 3.

Five Engineered Safety Features Actuation System (ESFAS) signals were generated during the event: the reactor trip, the start of the B Emergency Diesel generator (EDG), the start of the AFW pumps on low-low steam generator level, the containment ventilation isolation signal and the control room isolation signal.

The following describes specific equipment performance noted following the unit trip:

An electrical perturbation initiated a load shed on non-safety AC bus 1E resulting in a loss of power to busses 1E-1, 1E-2, 1E-3, half of the General Services bus (bus 1-4A, Section 2), and the 1B-SB safety bus. This perturbation occurred during the 1E Bus fast transfer process from the Unit Auxiliary Transformer to the Start up Auxiliary Transformer when 6.9 KV Breaker 122 tripped open and breaker 121 closed. During the fast transfer process an under-voltage time delay relay experienced a momentary contact closure, causing a false under-voltage signal. The momentary contact closure was induced by physical agitation of the relay during operation of two 6.9 KV breakers during the fast transfer. Since an actual under-voltage condition did not exist, the Under-voltage Lockout Relay 86UV/E (EIIS Code: EA-RLY) electrically reset.

The loss of power to B safety bus de-energized several radiation monitors causing actuations, including both a Containment Ventilation and Control Room Isolation Signals.

The Digital Rod Position Indicator system lost power due to de-energization of bus 1E-2. Power to this system was restored at approximately 2209 and full insertion of the control rods was verified.

As described above, the electrical perturbation isolated the feed for the B safety bus and automatically started the B EDG (EIIS Code: EK-DG). Appropriate B train safety equipment started as required via the emergency sequencer.

The standby A NSW pump did not start automatically when the B NSW pump tripped. The A NSW pump failed to start due to the short time period that the false under-voltage signal was present. The under-voltage signal is estimated to have been present for approximately 50 milliseconds, i.e., a duration equivalent to the reset time of the Under-voltage Lockout Relay 86UV/E. The automatic start circuitry for the A NSW pump has two relays in series, each with a pick-up time of approximately 50 milliseconds. Therefore, the under-voltage signal duration would had to have been present for at least 100 milliseconds to automatically start the A NSW pump.

EVENT DESCRIPTION (cont.)

The A EDG did not receive an emergency start signal during the event due to the successful transfer to the Startup Auxiliary Transformer. However, the operability of the A EDG was initially questioned due to conflicting status indications and was reported as such in the 4-Hour NRC Event Notification pursuant to 10CFR50.72(b)(2). These indications included: Generator Control Panel status lights, one of three 1D Bus under voltage device flags tripped and the tripped EDG 86DG relay. An investigation, including a review of the EDG 86DG lockout circuitry, was performed to determine the cause of these conditions, but was inconclusive. The fact that the "Maintenance" mode status light was the only indication on the EDG Control Panel indicates that no relay contacts from circuits which input to the EDG 86DG relay actually closed and initiated the trip signal. However, a momentary chatter on any of these relays could have caused the EDG 86DG relay to trip. Another possibility is that the voltage transient that occurred on the AC busses could have magnetically induced a trip of EDG 86DG trip coil in the Generator Control Panel. The EDG did not receive a valid under voltage start signal since only one of the 86UV flags on 1A-SA safety bus was tripped and power was not lost to the bus. If an emergency start signal had occurred during or after the transient, the EDG 86DG relay would have reset and the 1A-SA EDG would have started to provide emergency power to the 1A-SA safety bus.

While the operators were stabilizing the unit after the reactor trip and taking actions associated with the loss of the AC busses, full AFW flow to the steam generators resulted in Reactor Coolant System (RCS) temperature decreasing below the normal no-load temperature of 557 degrees F to approximately 537 degrees F. The RCS cooldown caused a decrease in the pressurizer level and a resulting increase in charging flow. The RCS letdown isolated at 17% pressurizer level. Automatic level control of the Volume Control Tank (VCT) did not function due to loss of power from bus 1E-2 to the boric acid flow transmitter. At approximately 2113, the VCT level decreased to

5% and the Charging/Safety Injection Pumps suction automatically transferred to the Refueling Water Storage Tank (RWST) as designed. The Reactor Operator did not detect the VCT low level alarm, nor the fact that the suction of the charging pumps automatically switched to the RWST, until a RWST Low Level Alarm was received at approximately 2152. (The lowest recorded RWST level was 94% which is greater than the Technical Specification required minimum of 92%). The AFW flow was reduced when directed by procedure, and the RCS temperature returned to its normal value of 557 degrees F at approximately 2131.

At approximately 2245 hours, operators manually started the A NSW pump. The discharge valve did not fully open and the valve opening timer did not trip the pump. Operators manually tripped the pump from the 6.9 KV breaker. Subsequent investigation concluded that Control Relay CR1/2189 (EIIS Code: KE-RLY) in the pump's discharge valve circuitry did not pick up and latch-in. This control relay failure caused both the failure of the valve to open and the failure of the pump to trip. The mechanical latch on the control relay was adjusted and the pump was subsequently started successfully.

At approximately 2255, operators manually started the B NSW pump. Indications in the Main Control Room showed the pump started and tripped approximately 30 seconds later. On subsequent attempts the pump started and the discharge valve opened as designed. Trouble shooting determined that the most probable cause of the pump trip was an intermittent problem associated with Control Relay CR4/2190 (EIIS Code: KE-RLY), which prevented the pump's discharge valve from opening as required. Control Relays CR4/2190 and CR1/2190 were subsequently replaced on May 23, 1996.

Further investigation and trouble shooting was performed in April 1997 during Refueling Outage 7 to determine the cause of the NSW pump/discharge valve problems. This investigation revealed that the torque switches on both NSW Pump Discharge Valves (1SW-289 & 1SW-287) were actuating when high D/P conditions existed across the valve and this was preventing the valve from opening to the 10% open position, which is required for pump operation. These high D/P conditions are present when the standby NSW pump starts with the other NSW pump not running. This now appears to be the most probable cause of the NSW pump trips following the April 25, 1996 reactor trip. Corrective actions to resolve this condition were taken as described in LER #96-018 Revision 1, which was submitted on August 7, 1997.

EVENT DESCRIPTION (Continued)

During the initial evaluation of Emergency Response Facility Information System (ERFIS) data from the reactor trip, it appeared to control room personnel that the pressurizer pressure master controller did not energize the backup heaters at the proper set point, and automatic energization of the B group of backup heaters was not blocked by the B sequencer operation. Subsequent investigation revealed that the Pressurizer Pressure Master Controller (PK-444A) performed properly and the B group backup heaters were blocked by the B sequencer as designed. Control room personnel involved in responding to the electrical transient and reactor trip were incorrect in their initial evaluation of data and the assumption that PK-444A had not performed properly.

CAUSE:

The failure of the A phase disconnect for unit output Breaker 52-7 was due to a high resistance connection resulting from the A phase switch jaw and blade contacts not being fully closed (blade not rotated into the horizontal position) and the presence of a high resistance surface coating. The reason for the switch not being fully closed is attributed to a misalignment in the mechanical linkage of the closing mechanism. High contact resistance, identified using thermography, was also noted on other breaker disconnects that did not fail. The misalignment in the disconnect mechanical linkage and the presence of the high resistance coating are both attributed to inadequate preventive maintenance for the disconnect switches.

SAFETY SIGNIFICANCE:

There were no significant safety consequences as a result of this event. The reactor tripped and the control rods fully inserted. The event challenged the automatic swapover of the unit auxiliaries to the Startup Auxiliary Transformer and initiated an under-voltage startup of the B EDG. Safety systems responded as required with the exceptions noted in the event narrative, to ensure unit safety and operators stabilized the unit in Mode 3. This event is being reported per 10 CFR 50.73(a)(2)(iv).

PREVIOUS SIMILAR EVENTS:

There have been no reactor trips caused by a switchyard breaker disconnect failure.

CORRECTIVE ACTIONS COMPLETED:

The following actions were performed prior to returning the unit to service on April 28, 1996:

1. The failed A phase disconnect switch on Breaker 52-7 was replaced.

Pitted contacts on the B phase blade and jaw were also replaced. The switch was adjusted and proper operation was verified.

2. The bus side disconnect switches on Breakers 52-7 and 52-9 were visually inspected with no problems identified. The unit side disconnect switch on the Breaker 52-9 was visually inspected and proper operation verified.

3. Transmission Department personnel provided initial training to some unit operations personnel on recognizing correct disconnect alignment.

4. The mechanical latch on the A NSW Pump discharge valve Control Relay CR1/2189 was adjusted.

5. Control Relay CR4/2190 for the B NSW Pump was replaced,

6. An assessment of control room operations staff performance was conducted. The review identified several areas where operator performance can be improved, including proactive control of key unit parameters such as AFW flow and recognition of some off-normal conditions.

7. The remainder of the disconnects in the switchyard were inspected to verify that blade contacts were properly seated. No other abnormally positioned disconnects were identified.

Following restart of the unit, the temperature of disconnect switches on Breakers 52-7 and 52-9 remained high as determined using infrared thermography. On May 3, 1996, the unit was removed from service and the disconnect contacts on the both the generator and bus sides of Breakers 52-7 and 52-9 were replaced. Contact resistance measurements verified successful repair of the breaker disconnect switches. After unit restart, thermography monitoring indicated expected operating temperatures.

CORRECTIVE ACTIONS COMPLETED (cont.)
The following actions have been completed since the original LER was issued:

8. Investigation of the pressurizer pressure control was completed on June 21, 1996. The Pressurizer Pressure Master Controller (PK-444A) functioned as required.

9. Investigation and confirmatory testing of the under-voltage relay momentary contact closure and associated false under-voltage signal were completed on June 26, 1996.

10. Additional testing as an effort to duplicate the EDG 86DG lockout relay trip in the A EDG control circuitry was completed on June 14, 1996.

11. The Superintendents-Shift Operations briefed appropriate operations personnel on the assessment of control room operation staff performance. This briefing was completed on June 19, 1996.

12. The preventive maintenance requirements for switchyard breaker disconnect maintenance have been revised and incorporated into Substation Maintenance Standard MNT-TRM-011. This was completed on September 24, 1996.

13. The "AC Electrical Distribution" Operating Procedure (OP-156.002) was revised to incorporate guidance on the operation of the switchyard breaker disconnects. This revision was completed on September 30, 1996. Training on the operation of the switchyard disconnects was also completed per Real Time Training Lesson Plan RTT-96-042 on September 30, 1996.

14. Licensed operators were trained on the importance of throttling Auxiliary Feedwater flow in a more timely manner to maintain the RCS temperature closer to the normal operating bounds and thereby minimizing cooldown. This training was completed during session #5 of the 1996 licensed operator requalification training program.

15. Licensed operators were trained to emphasize that several indicators, such as annunciators and VCT level, could have aided the operators in recognizing the realignment of the Charging/Safety Injection Pump suction. This training was completed during session #5 of the 1996 licensed operator requalification training program.

16. An off-site power system corrective action plan was developed and implemented in July 1996 by the system engineer to ensure that he becomes more intrusive in coordinating switchyard activities including predictive and preventive maintenance. In addition, the scope of switchyard work for the upcoming Refueling Outage 7 was established and integrated into the outage schedule. The establishment of switchyard work into the outage schedule was verified by Outage Management personnel on December 18, 1996.

17. Mechanisms for identifying correct alignment of disconnect switches

were evaluated to aid Operators and Transmission Maintenace
personnel. This evaluation was completed on December 10, 1996.
Based on a high level of confidence in determining disconnect
position resulting from the above mentioned training, additional
indicators were determined to be unnecessary.

18. Additional testing was performed on the Normal Service Water System
in April 1997 during Refueling Outage 7, which identified the
conditions described in the event description of this LER revision.
Corrective actions to address these conditions were delineated in
LER #96-018 Revision 1, which was submitted on August 7, 1997.

EIIS CODES:
Main Generator Output Breaker Disconnect: EL-DISC
Normal Service Water Pump: KG-P
6.8 KV Bus Under-voltage Lockout Relay: EA-RLY
Emergency Diesel Generator: EK-DG
Normal Service Water Pump Valve Control Relay: KE-RLY

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